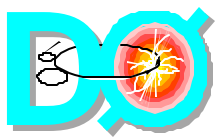


# Run 2b Upgrade Plans

Richard Partridge, Brown University  
for the DØ collaboration

- ◆ Physics goals for Run 2b
- ◆ DØ Run 2b upgrade strategy
- ◆ Run 2b upgrade activities and plans

Fermilab PAC Meeting  
April 14, 2000

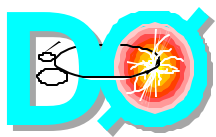


# Run 2b Physics Goals

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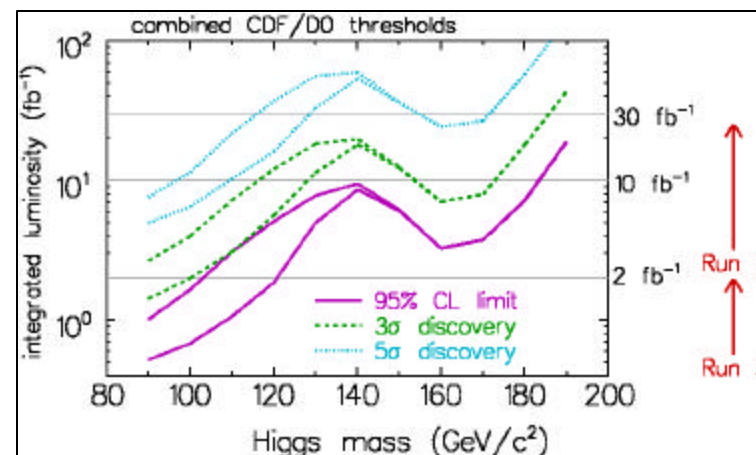
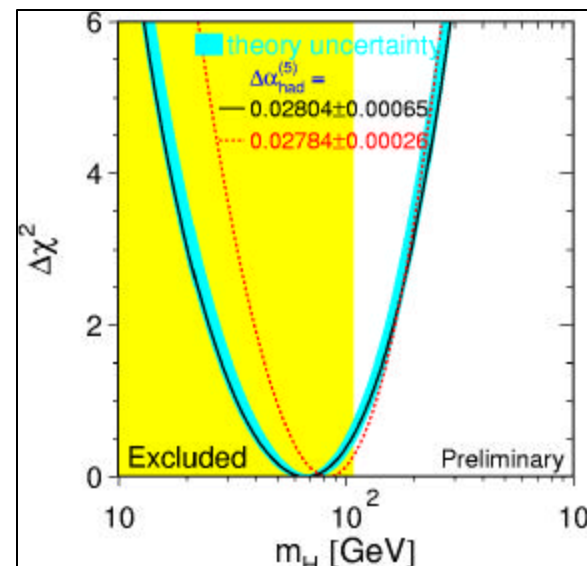
- ◆ Our goal is to achieve a “hat trick” of major discoveries!
  - » Top quark (done)
  - » SUSY or other physics beyond the SM (2a? 2b?)
  - » Higgs boson (2b?)
- ◆ ...but we already have a fall-back plan
  - » Precision measurements of  $m_W$ ,  $m_t \Rightarrow m_H$  (indirect)
  - » CP violation in B decays
  - » Detailed study of top quark properties
  - » Many new particle searches
  - » QCD studies at high and low  $Q^2$
  - » etc. etc.
- ◆ Full range of DØ physics topics see significant benefits by “Factor of 10” increase in integrated luminosity in Run 2b

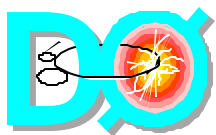




# Higgs Hunting in Run 2b

- ◆ Present SM Higgs Mass limits (95% CL):  
 $M_H > 107.7 \text{ GeV}$  (direct)  
 $M_H < 188 \text{ GeV}$  (indirect)
- ◆ With  $\sim 20 \text{ fb}^{-1}$ , CDF+DØ have good sensitivity for SM Higgs:
  - » 5+ s.d. discovery for  $m_H < 125 \text{ GeV}$
  - » 3+ s.d. discovery for  $m_H < 180 \text{ GeV}$
  - » Exclude SM at 95% CL if there is no sign of the Higgs in Run 2b
- ◆ Higgs hunting is critically dependent on maximizing the integrated luminosity in Run 2b





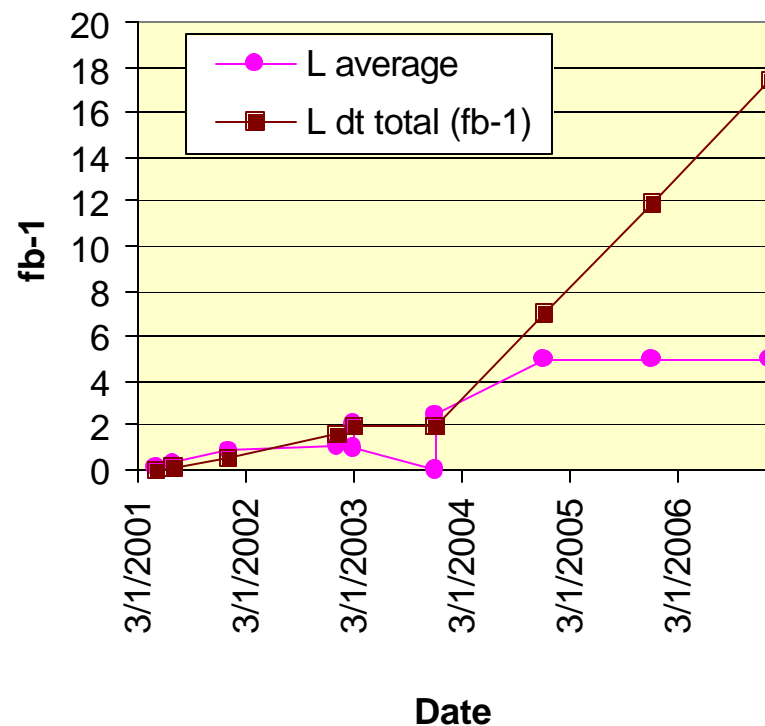
## One Possible Scenario

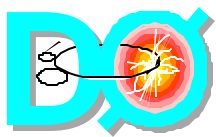
2001-2003 2 fb<sup>-1</sup> (Run 2a)

2003 Run 2b upgrade

2004-2007 15 fb<sup>-1</sup> (Run 2b)

- ◆ Narrow window of opportunity for Run 2b upgrades
- ◆ No more than one major shutdown
- ◆ Need high luminosity ( $\sim 5 \times 10^{32} \text{ cm}^{-1} \text{ s}^{-1}$ ) starting in  $\sim 2004$  to meet Run 2b goals





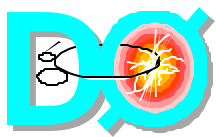
## Run 2b Upgrade Strategy

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- ◆ Primary goal is to maintain capabilities of Run 2a detector
- ◆ Focus is on fixing problems brought on by accumulated radiation dose and/or high instantaneous luminosity

Need to perform “4C” fit:

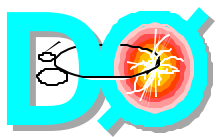
- ◆ Radiation damage, high occupancy  $\Rightarrow$  need to modify or replace some detector elements
- ◆ Limited window of opportunity  $\Rightarrow$  minimize downtime and schedule risk
- ◆ Limited resources  $\Rightarrow$  minimize scope of Run 2b upgrade
- ◆ Challenging physics goals  $\Rightarrow$  exploit opportunities to improve sensitivity to key physics processes



## DØ Run 2b Activities

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- ◆ Early DØ studies identified opportunities and potential problems in high luminosity running
  - » Snowmass 96
  - » “DØ Detector at TeV33”
- ◆ DØ revived discussion of future silicon detector options in Fall 99
- ◆ Regina Demina and Richard Partridge appointed to chair “Beyond 2 fb<sup>-1</sup>” working group in January
- ◆ Beyond 2 fb<sup>-1</sup> mini-workshop held in early March to review effects of radiation, occupancy on Run 2a detector
- ◆ Amid furious effort to complete Run 2a upgrade, serious investigation of Run 2b upgrade options has begun



# Major Problems

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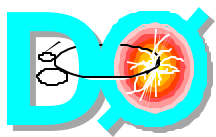
## Radiation damage to silicon vertex detector

- ◆ Radiation increases effective doping concentration, requiring increased bias voltage to deplete silicon sensor
  - » Depletion voltage will exceed breakdown voltage after  $\sim 4 \text{ fb}^{-1}$  for innermost layer (Layer 1)
  - » Layer 2 expected to survive  $\sim 10 \text{ fb}^{-1}$
  - » Layers 3, 4 are probably OK up to  $\sim 20 \text{ fb}^{-1}$

## Trigger rates

- ◆ Higher instantaneous luminosity requires increased rejection to maintain acceptable trigger rates
- ◆ Increased minbias pileup decreases trigger rejection
- ◆ Radiation damage in inner fiber layers may require loosening the track trigger requirement





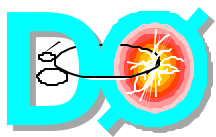
# Silicon Options

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- ◆ Need to replace layers 1, 2
  - » May use “sandwich” of axial and stereo single-sided detectors rather than double-sided detectors
  - » Split silicon design may allow replacement without rolling out
- ◆ Strong physics motivation for additional layer(s)
  - » Sandwich design increases multiple scattering, degrades b-tagging
- ◆ Several options presently under consideration:
  - » 25  $\mu$  pitch layer 0
  - » Inner pixel layer
  - » Replace inner fiber layers with outer silicon layers 5 and 6
- ◆ Can probably avoid development of new SVX readout chip
  - » ~2,700 untested SVX2 readout chips “banked” at UTMC
  - » Expect additional ~1000 SVX2 chips to be left after Run 2a upgrade
- ◆ Silicon R&D is critical and must begin soon



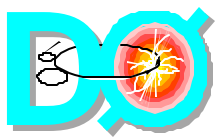




# Trigger Upgrade

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- ◆ Focus on meeting trigger requirements through incremental upgrades to various trigger systems
- ◆ Trigger upgrades generally don't require major shutdown
- ◆ Possible trigger upgrades include:
  - » Improved Level 1 jet trigger
  - » Improved Level 1  $\phi$ -matching between calorimeter and tracker/preshower
  - » Level 2 processor upgrades
  - » Level 2 STT upgrade
  - » Level 3 processor upgrade
  - » Data path upgrade to allow higher Level 2, Level 3 trigger rates
- ◆ Need to develop an integrated and coherent trigger upgrade plan to achieve a balanced trigger with a sensible division of trigger bandwidth



# Potential problems

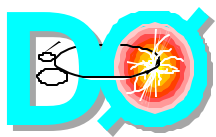
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## SIFT chip operation

- ◆ SIFT chip contains discriminators that tell the fiber tracking trigger whether a fiber has been hit or not
- ◆ Noise problems may preclude 132 ns operation with the current design
- ◆ New design required?

## Central muon PDT aging and occupancy

- ◆ Central muon B/C layer PDT's require periodic “zapping” to remove wire crud
  - » Estimate zapping may be required every  $\sim 1 \text{ fb}^{-1}$
- ◆ Occupancies expected to be several % in central PDT's
  - » Is this a problem?

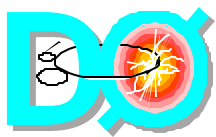


# Unplanned Upgrades and Fixes

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- ◆ Expect variety of small upgrades and detector fixes to be introduced during Run 2 to address specific problems
- ◆ Many examples of such upgrades in Run 1
  - » cosmic shield counters
  - » Level 1 trigger changes
  - » Processor farm upgrades
  - » tracker alignment fibers
  - » luminosity monitor scintillator changes
  - » etc.
- ◆ Such upgrades are likely to be limited in scope and funding, but require flexibility



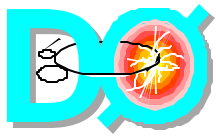


## Run 2b Upgrade Plan

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- ◆ The “beyond 2 fb<sup>-1</sup>” mini-workshop was extremely helpful in reviewing what we presently know about high luminosity running
- ◆ Next step is to flesh out the most promising upgrade options, begin MC design studies, and develop a plan for R&D funding in FY2001
- ◆ Plan to utilize June DØ workshop to develop consensus on most urgent R&D needs





## Conclusions

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- ◆ Compelling physics case for Run 2b with maximum possible integrated luminosity
- ◆ DØ has begun planning for Run 2b upgrade
- ◆ Silicon and trigger upgrades are likely to be necessary
- ◆ SIFT chip and muon central PDT aging/occupancy are areas for concern
- ◆ Additional mini-upgrades are likely
- ◆ Next step is to identify most promising options and develop R&D plan